EFFECTS OF HABITAT CHANGE ON BREEDING WATERBIRDS IN ARIN (SODALI) LAKE, TURKEY

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Abstract. Defining the response of waterbirds to habitat change is of great importance for providing useful inputs for conservation studies of wetland ecosystems. However, little is known about the effects of water level fluctuation and habitat change on waterbirds. Therefore, it is urgent to analyze the relationship between them. Arin Lake being one of the Important Bird Areas in Van Lake Basin of Turkey is a very significant area in terms of birds. In this study, we analyzed the relationship between the changes in the abundance and distribution of waterbirds and the changes in their habitat structure using GIS (Geographical Information Systems) Analysis methods. Between 2013-2015, 51 waterbird species were observed in the research area. Significant increases were detected in swamp, sandy areas and wet grasslands while the total area of clear water surface and reed beds decreased. Changes in the population densities of Anatidae, Podicipedidae and Rallidae were positively correlated with the changes in the clear water surface and reed bed habitats while Ardeidae, Haematopodidae, Recurvirostridae, Charadriidae, Scolopacidae, Laridae and Sternidae were significantly negatively correlated with. The most commonly represented families were Anatidae and Scolopacidae, with 15 and 11 species. Our results demonstrated that water level fluctuation and habitat change affected the habitat quality, population size, distribution and habitat preferences in feeding and breeding areas of waterbirds resting and breeding in the area. Consequently, we recommend that urgent conservation measures should be taken to protect sensitive habitats of Arin Lake and bird species dependent on the wetland.
Keywords: *biological conservation, habitat degradation, water level, GIS, wetlands, Van Lake Basin*

Introduction

In a rapidly industrializing and urbanizing world, the habitats of species become narrow and is destroyed gradually together with destruction of natural environment. One of the most endangered ecosystems around the world are wetlands (Ma et al., 2009). Waterfowls are birds dependent on wetlands, lakes, deltas, streams, marine environments in order to live. Therefore, determining population size and habitat of waterfowls is crucial for protection of wetlands and waterfowls. 184 Important Bird Areas (IBA) have been detected in Turkey by International Bird Protection Institution (BirdLife International). IBA's having importance at regional and international level with regard to protection of birds is potential Natura 2000 sites defined according to Regulations of European Union (Heath et al., 2000; Yarar and Magnin, 1997; Eken et. al., 2006). It is necessary to carry out protection and monitoring studies for these areas that most of those have not protection status in spite of exposing to various anthropogenic effects.

Relationships between habitat and bird communities has been a major part of conservation and environmental management for decades (Gül et al., 2013). In recent years, many researchers have indicated that habitat destruction is the main factor

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causing bird extinction (Sisk et al., 1994; Bibby, 1995; Fahrig, 2001). In this study, the population density and habitat preferences of waterbirds in Arin Lake, being an important bird area, were determined through using GIS analysis methods. We detected that the water level and habitat types of the lake have changed throughout the years due to the anthropological pressures and significant fluctuations in rainfall. It is thought accordingly that data of this study will make significant contributions to international and local protection studies.

Materials and Methods

Arin Lake is located in eastern Turkey (42º98'E, 38º80'N), it is a saline soda lake. The lake is surrounded by three villages located southeast of Süphan Mountain. This part of Turkey has the second highest annual rainfall in Turkey (380-436 millimeters per year), which receives precipitation throughout the year with an annual average temperature of 9.8°C (min -3.2°C and max. 22.5°C) (Eken et al., 2006; Anonymous, 1993; Anonymous, 2015). The wetland surrounded with small marshes and reeds is mainly fed by groundwaters and precipitation. Cattail (*Typha* sp.) and Common reed (*Phragmites* sp.) communities mainly dominate the reed bed habitat but illegal reed fires are quite widespread at the area.

In this study, the population density and habitat preferences of waterbirds in Arin Lake, being an important bird area, were determined through using GIS Analysis methods. Observation studies were carried out between March 2013 and October 2015. The study area comprising a total of 4392 ha is composed of 309 Universal Transverse Mercator (UTM) grids and two count stations within each grid. The species have been determined by Point Count method (Dobinson, 1976; Bibby and Burgess, 1992). The bird detections for each station were written separately on the field form. We evaluated relationships between waterbird populations (species number and density) and habitat changes in Arin Lake.

The total number of waterbird species with and without breeding evidence were compared between 2013-2015. The impact of habitat displacement, number of breeding waterbirds were assessed statistically. Statistical analysis was conducted in order to assess and compare triennial landscape data. To determine if there is a difference between habitats and years pertaining population size ANOVA method and Chi-square test were used.

Results and Discussion

Between 2013-2015, 51 waterbird species belonging to 12 families were observed in the research area. The most commonly represented families were Anatidae and Scolopacidae, with 15 and 11 species (*Table 1*). Rare species have been observed, such as white-headed duck (*Oxyura leucocephala*), common pochard (*Aythya ferina*), Eurasian coot (*Fulica atra*), Armenian gull (*Larus armenicus*) and white-winged tern *(Chlidonias leucopterus*), similar to previous studies (Adızel, 1998; Nergiz, 2010).

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Table 1. *Population density of waterbirds observed in Arin Lake during the study period of 2013-2015*

Spesies	2013 Population density	2014 Population density	2015 Population density	2013 breeding pair	2014 breeding pair	2015 breeding pair	Habitat
FAM: PODICIPEDIDAE							
1. Podiceps cristatus	76	66	52	12	8	6	reed
2. Podiceps grisegenea	322	308	264	56	35	28	reed
3. Podiceps auritus	164	156	147	42	36	32	reed
4. Podiceps nigricollis	141	134	128	34	25	20	reed
5. Tachybaptus ruficollis	193	168	154	46	32	26	reed
FAM: PHALACROCORACIDAE							
6. Phalacrocorax carbo	5	5	5				sandy
FAM: ARDEIDAE							
7. Ardea cinerea	3	4	3				swamp
8. Ardea purpurea	2	3	3				swamp
9. Egretta alba	2	4	4				swamp
10. Egretta garzetta	12	15	17				swamp
11. Ardeolla ralloides	4	6	7				swamp
12. Bubulcus ibis	6	6	7				swamp
13. Nycticorax nycticorax	4	12	13				sandy
FAM: CICONIIDAE							
14. Ciconia ciconia	4	4	4				agricultural land
FAM: ANATIDAE							
15. Cygnus cygnus	6	5	4				water surface
16. Anser anser	12	8	6				water surface
17. Anser albifrons	4	3	2				water surface
18. Tadorna tadorna	65	72	78				water surface
19. Tadorna ferruginea	352	362	384				water surface
20. Anas platyrhynchos	218	196	183	27	24	21	water surface
21. Anas crecca	123	119	103				water surface
22. Anas strepera	4	4	4				water surface
23. Anas querquedula	8	6	5				water surface
24. Anas penelope	12	11	8				water surface
25. Anas cylpeata	425	400	386	16	22	18	water surface
26. Netta rufina	644	578	565				water surface
27. Aythya ferina	862	630	637	52	52	48	water surface
28. Aythya fuligula	254	212	200				water surface
29. Oxyura leucocephala	863	820	795	17	14	12	water surface
FAM: RALLIDAE							
30. Rallus aquaticus	3	3	2	1	1	1	reed
31. Fulica atra	3000	2913	2714	150	162	162	water surface

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FAM: HAEMATOPODIDAE							
32.Haematopus ostralegus	4	5	8				sandy
FAM: RECURVIROSTRIDAE							
33.Himantopus himantopus	119	126	132	18	22	25	grassland
34. Recurvirostra avosetta	274	280	285	12	16	18	grassland
FAM: CHARADRIIDAE							
35. Vanellus vanellus	314	320	334	27	31	36	grassland
36. Charadrius dubius	24	32	34				grassland
FAM: SCOLOPACIDAE							
37. Calidris minuta	151	166	171				sandy
38. Tringa totanus	289	301	307	14	18	19	sandy
39. Actitis (T.) hypoleucos	56	65	69				sandy
40. Tringa stagnatilis	44	58	62				sandy
41. Tringa ochropus	41	55	63				sandy
42. Tringa nebularia	30	38	44				sandy
43. Philomachus pugnax	182	194	216				sandy
44. Limosa limosa	4	4	4				sandy
45. Scolopax rusticola	3	4	5				sandy
46. Gallinago media	2	2	3				sandy
47. Gallinago gallinago	2	2	3				sandy
FAM: LARIDAE							
48. Larus ridibundus	455	463	478				water surface
49. Larus armenicus	895	942	254				water surface
FAM: STERNIDAE							
50.Chlidonias leucopterus	951	963	972				swamp
51. Sterna hirundo	127	133	146				swamp

The major habitats were swamp, wet grasslands, sandy areas, reeds, clear water surface and agricultural lands. The water level of Arin Lake decreased significantly in 2014-2015 due to a drought. In addition, human intervention observed at the same time in the lake resulted in dramatic losses of reed beds which had a significant negative impact on breeding waterbirds. In addition agriculture and grazing were conducted extensively around the lake. So, reed beds around the lake destroyed seriously due to grazing.

Significant increases were detected in swamps, sandy areas and wet grasslands while the total area of clear water surface and reed beds decreased (*Figure 1*).

The number of individuals using swamp, sand areas and wet graslands increased from 2013 to 2015. However, the number of individuals using the clear water surface and reed beds exhibited the decreasing trend from 2013 to 2015 (*Table 2*) ($p<0.05$). There was statistically important difference in population size and habitat structure between years ($p<0.05$). The total number of waterbirds significantly decreased in 2015.

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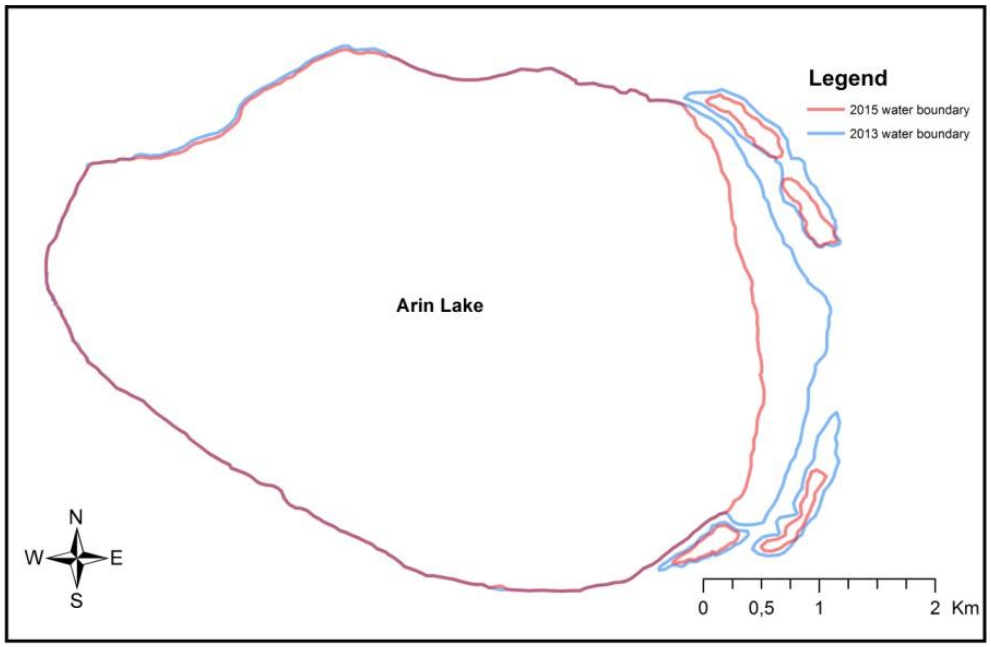

Figure 1. *Water boundary changes in Arin Lake*

Table 2. *Comparison of the total number of individuals identified per major habitat*

	Population density of 2013(n)	Population density of 2015(n)	p
Swamp	1107	1159	0,001
Reeds	899	747	0,083
Grassland	731	785	0,001
Clear water surface	7785	6344	0,001
Sandy	1396	1718	0,001
Agricultural land	4	4	0,885
Total population in Arin Lake	**11922**	**10757**	**9.8 % decline**

The total number of waterbirds per UTM grid in 2013 and 2015 are shown in *Figure 2* and *Figure 3*. Our results demonstrated that water level fluctuation affected the habitat quality, population size, distribution and habitat preferences in feeding and breeding areas of waterbirds resting and breeding in the area. The changes in the population densities of Anatidae, Podicipedidae and Rallidae were positively correlated with the changes in the clear water surface and reed bed habitats but negatively correlated with the changes in the swamp, sandy areas and wet grassland habitats. The densities of Ardeidae, Haematopodidae, Recurvirostridae, Charadriidae, Scolopacidae, Laridae and Sternidae were significantly positively correlated with the swamp, sandy areas and wet grassland habitats but significantly negatively correlated with the reed bed habitats.

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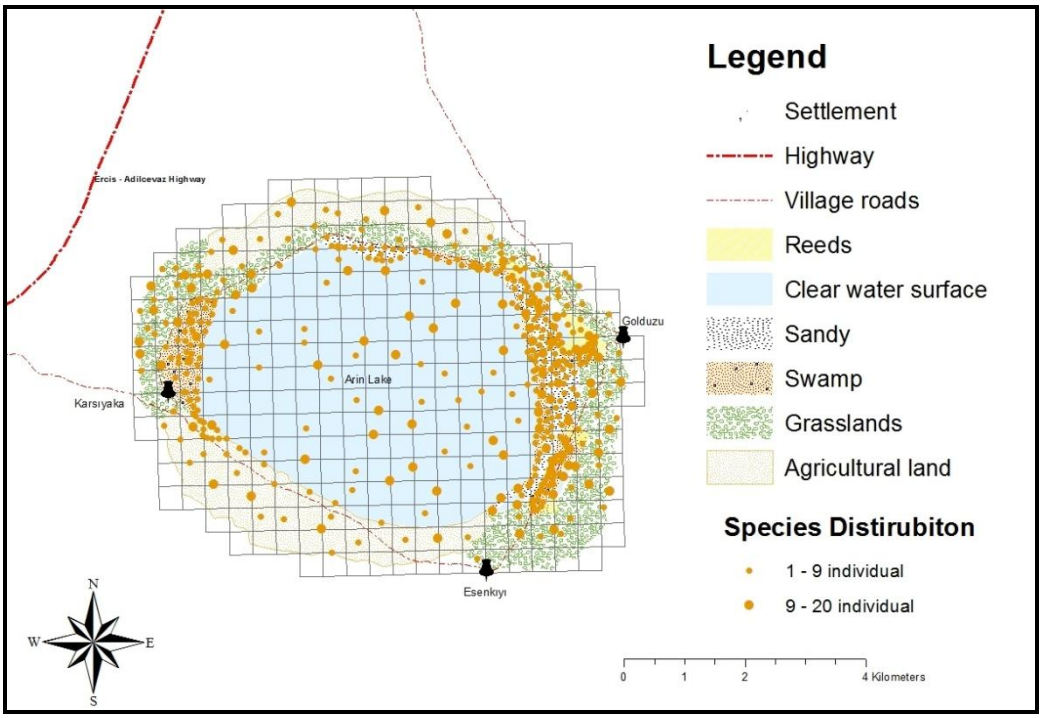

Figure 2. *The distribution of the waterbirds and major habitats in Arin Lake in 2013*

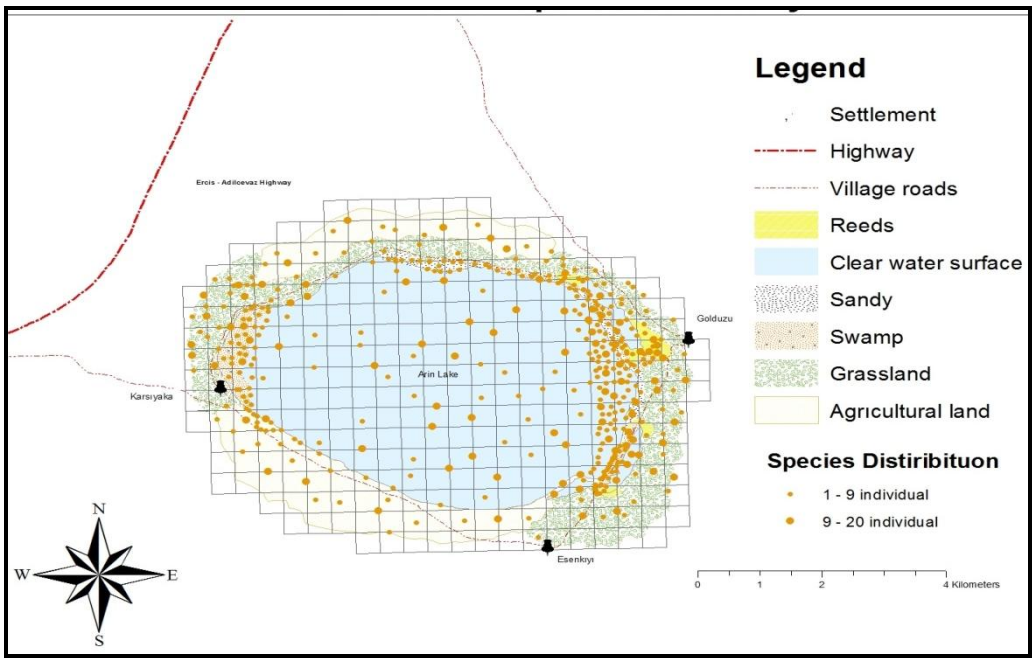

Figure 3. *The distribution of the waterbirds and major habitats in Arin Lake in 2015*

We observed that species with similar ecological demands tend to respond similarly to the habitat changes. It is well known that reed bed habitats were foraging sites of waterbirds (Huang et al., 1993; Yu et al., 1995; Holm et al., 2006; Webb et al., 2010; Stralberg, 2011; Zou et al., 2014). But, in present study, changes in the species number and densities of most waterbirds were positively correlated with the changes in the

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mudflat and shallow water habitat. Charadriidae was significantly positively correlated with the deep water habitat (Jing et al., 2007; Zou et al., 2016); however, in present study, changes in the individual number of the species was negatively correlated with the changes in the mudflat and shallow water habitat.

The positive correlation between the waterbird populations and the sandy and shallow water habitats might not infer the positive effect of such habitat to waterbirds like the great snipe (*Gallinago media*) and the black-tailed godwit (*Limosa limosa*) which are classified by IUCN (The International Union for Conservation of Nature) as near threatened. As these lands were very close to settlement units and illegal hunting activities in area was very widespread, the pressure on waterfowl increased more.

Arin Lake is a very significant area in terms of birds. Especially in migration periods, this importance increases in world scale. *O. leucocephala* under extinction threat all around the world breeds at great numbers and rests here in migration period. During the autumn migration period, 863 individuals were observed in 2013 and 795 in 2015. That means population reduction tendency continues in Arin Lake. In addition the whooper swan (*Cygnus cygnus*) resting at important numbers in fall migration period (Adızel, 1998; Nergiz, 2010; Durmuş and Nergiz, 2013). Changes in the population sizes of four dominant waterbirds such as *O.leucocephala, A. ferina*, and *F. atra* were positively correlated with the clear water surface and reed bed habitats. Therefore, loss of these habitats might mean a decrease in foraging habitats for most waterbirds at Van Lake Basin. Consequently, we recommend that urgent conservation measures should be taken to protect sensitive habitats of Arin Lake and bird species dependent on the wetland.

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